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Evaluation of Elastomeric Components for the Arctic Forward Area Refueling System

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The elastomeric components of an Arctic Forward Area Refueling Equipment (AFARE) system, developed contractually and consisting of collapsible fuel storage tanks of various sizes, 500-gallon fuel drums, and suction and discharge hoses, were evaluated to ascertain conformance to relevant military specifications.

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Contents

Figures

Tables

Introduction

Background

The Engineering Materials and Coatings Branch of the U.S. Army Research Laboratory (ARL), has actively participated in a continuing co-operative program with the Fuels Handling Division, currently of the Tank Automotive Research, Development, and Engineering Center (TARDEC). The primary purpose has been to evaluate the performance characteristics and specification or purchase description conformance of various rubber-based components of field-emplaceable air and land vehicle refueling systems. Rubber-based components comprising a typical system are rubber-coated fabric fuel storage (pillow) tanks of various sizes, fuel suction and discharge hoses, and 500-gallon air-droppable fuel drums. Two classes of refueling systems are currently in use, one designed for service in tropic and temperate environments, and another specifically engineered for Arctic service, the so-called Arctic Fuel System Supply Point (AFSSP) which provides storage capabilities for the Arctic Forward Area Refueling Equipment system (AFARE). The AFSSP and AFARE systems are depicted in Figures 1 and 2, respectively.

Through combined contractual and in-house effort, the Engineering Materials and Coatings Branch developed the end items covered in this report. The branch has also addressed several fuels handling system-related problems such as developing gaskets for Arctic hose couplings and ascertaining why fuel spillage promoted a shortening of the service life of tanks coated with urethanes. The latter is detailed in the Belvoir Research Development and Engineering Report Number 2519 titled "Extending the Service Life of Urethane Fuel Tanks." Numerous internal reports have been prepared covering evaluation of hoses and candidate-coated fabrics for tanks and drums and recommendations for improving test and evaluation procedures.

Objective

This report covers testing and evaluation of components of an AFARE system developed for the Fuels Handling Division with all contractual efforts monitored by Engineered Air Systems Corporation, St. Louis, MO. Supplemental assistance was provided by Aviation Troop Command (ATCOM) procurement personnel.

The specific system components covered in this evaluation, the relevant specifications, and the end item fabricators are listed as follows:

- 3K-, 10K-, and 20K-Gallon Fuel Tanks - MIL-T-53101 fabricated by Bell Avon, Picayune, MS.
- 500-Gallon Fuel Drum - MIL-D-53092 fabricated by Amfuel, Magnolia, AR.
- Collapsible Fuel Hoses - MIL-H-53095 fabricated by Goodyear, St. Alphonse De Granby, Quebec, Canada, and Gates Rubber Company, Denver, CO.
- Non-Collapsible Fuel Hoses - MIL-H-53096 fabricated by Goodyear, St. Alphonse De Granby, Quebec, Canada, and Gates Rubber Company, Denver, CO.

No fuel drums or tanks were submitted for testing, only samples of the materials from which the items would be fabricated. Lengths of hose in the various sizes required for system deployment were provided by both Goodyear and Gates.

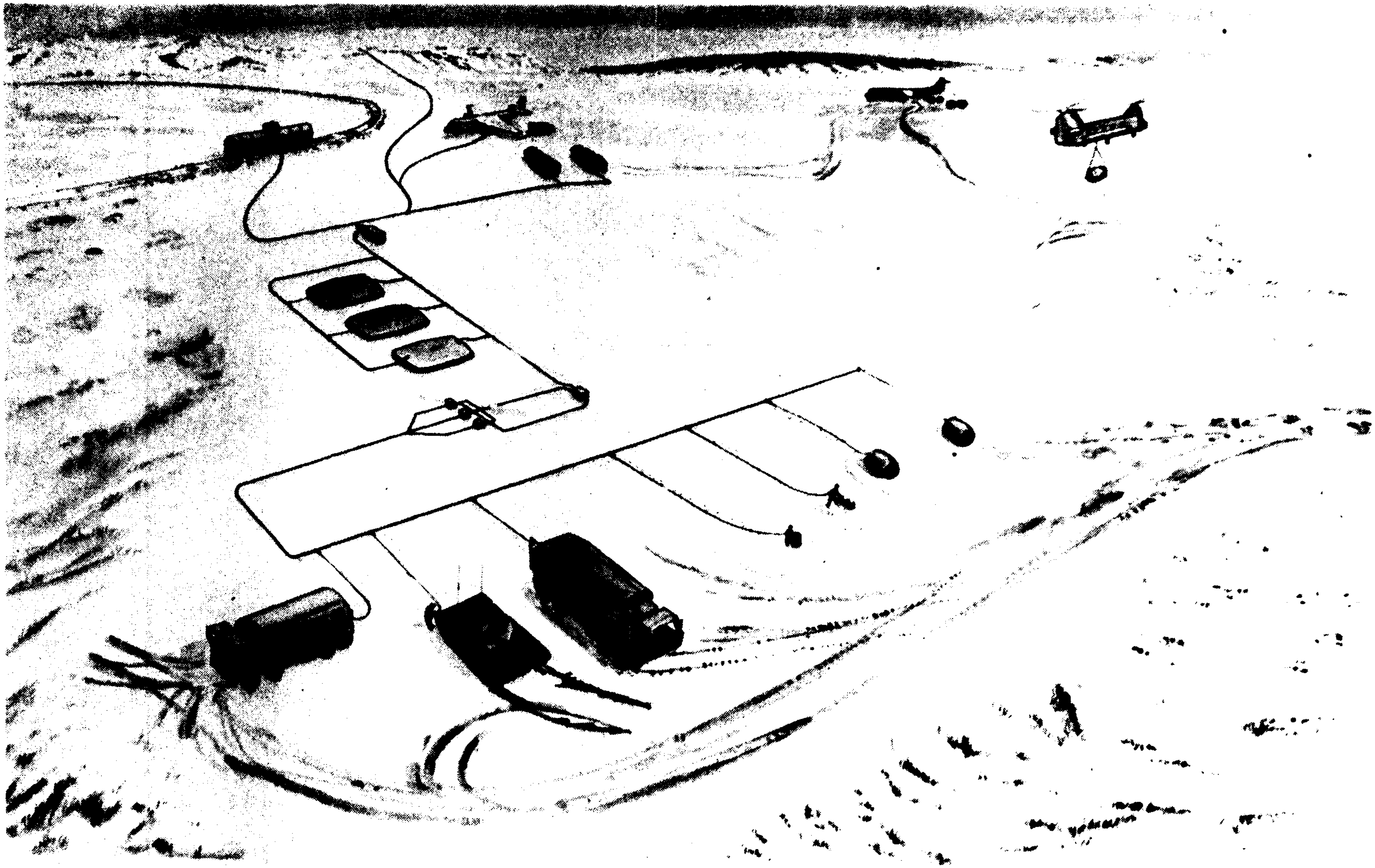

Figure 1. Arctic Fuel System Supply Point

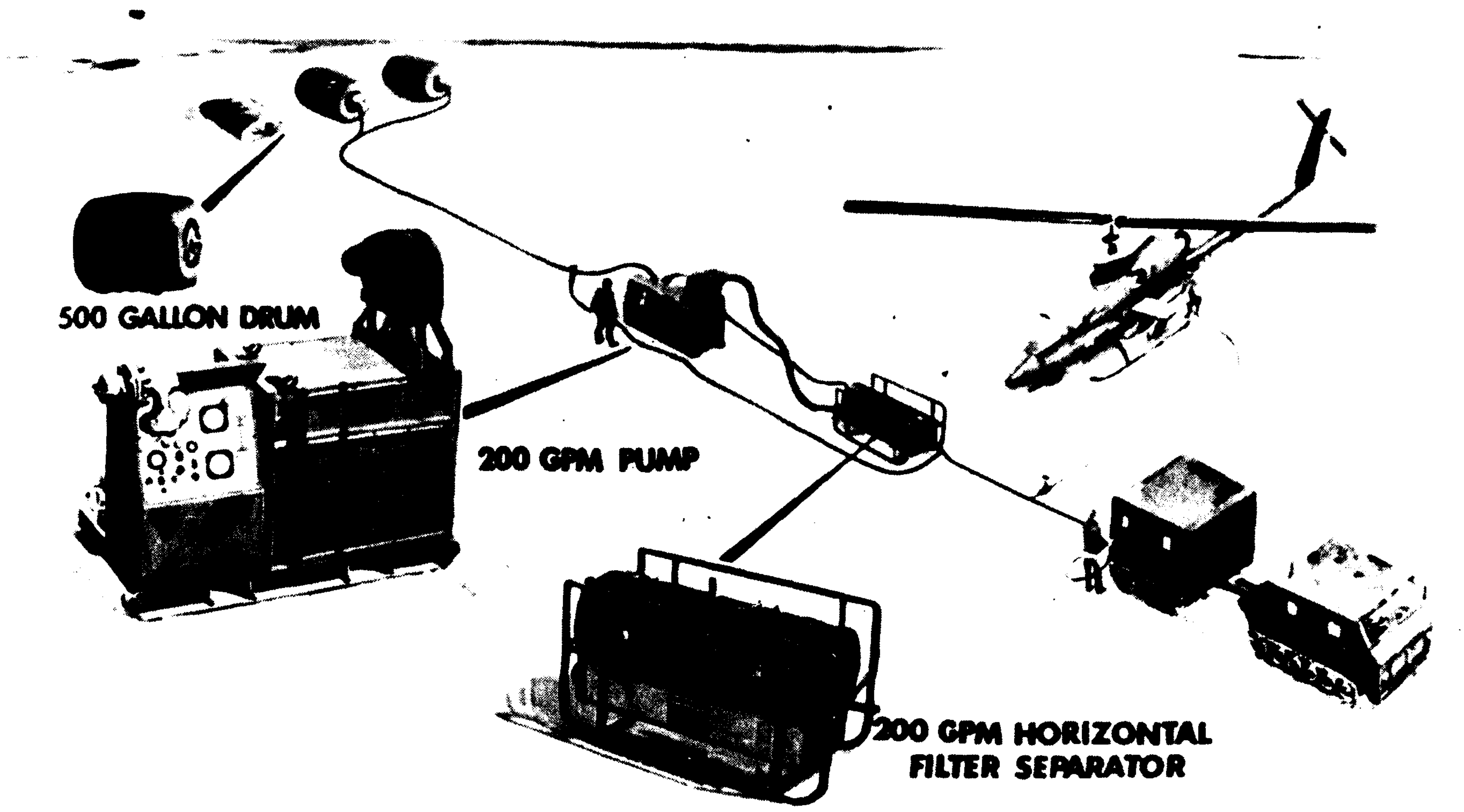

Figure 2. Arctic Forward Area Refueling Equipment

Test Program

Conformance Testing

All testing was conducted according to detailed procedures cited in the drum, tank, and hose specifications listed above and/or the applicable ASTM or Federal Test Method Standard 191 test methods.

Supplemental Testing

In-house studies, covered in the report cited above, demonstrated convincingly that ultra-violet inhibitors and hydrolytic stabilizers incorporated in urethane-coated fabrics such as that proposed by Bell Avon for tank fabrication may be leached out as a result of unintentional external surface contact with the contained fuel. This could result in coated fabric and seam failures; therefore, an extraction/immersion test procedure was developed to ascertain the likelihood of such an occurrence. The procedure was included in the MIL-T-53101 tank conformance test plan and is detailed as follows:

1. Immerse test specimens in JP-5/JP-8 ST fuel conforming to MIL-T-5624 for seven days at $160^{o}F \pm 2^{o}F$.

2. Remove specimens from fuel and blot with paper towels.

3. Place specimens in a vacuum-drying oven for 16 hours ± two hours at $120^{o}F$ at a reduced pressure of 20 in. of Mercury.

4 Immerse specimens in distilled water for the specified period, usually 14 or 42 days at $160^{o}F \pm 2^{o}F$.

5. Determine physical properties, as applicable to coating compounds, coated fabrics, or seams, on the aged specimens.

The above procedure has been proposed as a new procedure to be incorporated in the tank specification MIL-T-53101.

ASTM Reference Fuel B was the immersion medium employed by Gates and Goodyear in hose testing while ARL results were based on JP-5/JP-8 ST.

Test Results

Results of tests conducted on tank and drum materials and actual samples of the various sizes of collapsible and non-collapsible hoses are summarized in Tables 1 through 9 as follows:

Table 1 - Results for Tank Coating Compound

Table 2 - Results for Tank Coated Fabric

Table 3 - Results for Tank Seams

Table 4 - Results for Tank Bonded Fittings

Table 5 - Results for 500-Gallon Drum

Table 6 - Results for Collapsible Hoses - Gates

Table 7 - Results for Collapsible Hoses - Goodyear

Table 8 - Results for Non-Collapsible Hoses - Gates

Table 9 - Results for Non-Collapsible Hoses - Goodyear

Comparative data was obtained from all suppliers and these results are included in the above tables.

Discussion of Results

MIL-T-53101 Tank Components

Coating Compound

While the initial tensile strength and elongation of the urethane coating compound is more than adequate, retention of these properties and volume changes after immersion in JP-8 and ASTM Fuel B are unfavorable, as annotated in Table 1. The compound failed to meet volume swell requirements whether exposed to either fuel. After undergoing the proposed extraction/immersion procedure, the 14-day volume swell and property retention results were comparable to those for Fuel B immersion, but the 42-day results indicated possible continued extraction of stabilizers. For unexplained reasons, tensile retention after 14 days immersion in water was less than that observed after extraction/immersion for a similar duration but volume swell was lower. The results for 42 days water immersion were inadvertently lost. Limited immersion testing conducted by Bell Avon; tensile strength retention after Fuel B and water exposure produced higher values than would be expected.

Bell Avon reported 98% retention of the coating compound's tensile strength after 1500 hours of accelerated weathering. Additionally, favorable results were obtained by both ARL and Bell Avon relative to washed gum, ozone resistance, and brittleness at -60°F. The modulus of rigidity at -60°F (31,823) was indicative of significant stiffening of the coating compound. This could impact on the ability to readily deploy an AFARE system.

Coated Fabric

Results for the coated fabric testing, summarized in Table 2, indicate generally acceptable conformance to the MIL-T-53101 requirements. Of particular note is that Fuel B diffuses through the material about five times more readily than JP-8. This is probably due to the higher aromatic content of the former. The breaking strengths obtained in both the warp and fill direction are acceptable for 3K- and 10K-gallon tank materials, but would not satisfy the 500 lb/in. requirement for the 20K-gallon tank. Puncture resistance (154 pounds) is adequate for all sizes.

Bell Avon opted to use a single-coated fabric for construction of all tanks regardless of size. Their data was extracted from a test report provided by Seaman Corporation, the supplier. Results were comparable with tear and breaking strengths and puncture resistance values were higher than those reported by ARL. Retention of breaking strength after weathering and exposure to fungi and diffusion of Fuel B after creasing and low temperature exposure was also favorable.

Seams

Noticeably poor results were evident for the original group of fabricated seams subitted by Bell Avon for evaluation. Subsequently, the contractor provided a second group upon which all results in Table 3 are based. The initial breaking strength for these seams was adequate for 3K and 10K tank construction but did not conform to the higher requirement for 20K tanks. The breaking strengths claimed by Bell Avon, using specimens taken from fabricated 10K and 20K tanks, indicated conformance in all cases. Direct immersion in JP-8 or water for 14 days produced an apparent increase in bond strength in the former instance and a slight decrease in the latter. In both cases, conformance to the 20K requirement of 400 lbs/in., minimum, was maintained. JP-8 and Fuel B extraction/immersion testing for 14 and 42 days produced conformance to all 3K and 10K requirements. Only the 42 day, JP-8-extracted specimens satisfied the 20K requirement. Bell Avon reported high but conforming values after Fuel B and water immersion.

Data for seam peel adhesion was satisfactory for almost all configurations tested, both initially and after fuel immersion. One instance of failure was observed; the chafing patch after 14 days water immersion. Testing of JP-8 and Fuel B-extracted specimens was restricted to typical seams only. Here, failures were noted for specimens immersed in water for 14 days; however, subsequent testing after 42 days immersion evidenced no further loss of adhesion and, thus, conformance to the lower requirement. Bell Avon reported seam peel failures in four of the five Fuel B exposures of 10K tank seams and conformance in all other cases.

Performance of both the coated fabric and the seams thereof was generally better than would have been expected, particularly the poorer results observed for the coating compound.

Bonded Fittings

The U.S. Army Research Laboratory results, cited in Table 4, indicate that the force required to separate the coated fabric from segments of curved and straight access, and vent drain fittings, was less than the minimum required by MIL-T-53101. Bell Avon data for specimens taken from 10K and 20K tanks denote conformance. However, as has been observed in similar testing of other fuel tank fittings, a strengthening of the metal/coated fabric bond may occur during periods of immersion in fuels or even water. Thus, the higher, conforming values after immersion as reported in Table 4 would be considered favorable and in all probability are not outliers. Since the number of specimens that can be cut from a fitting is limited, no testing of extracted/immersed segments was performed. Both ARL and Bell Avon reported acceptable initial aluminum strip/coated fabric peel adhesion. Peel adhesion after JP-8 extraction and immersion in distilled water for 14 days was only 6 lbs/in., below the minimum requirement of 20 lbs/in. for all three tank sizes. . This very limited data is obviously inconclusive; however, based on the positive results obtained in dead-load and post-immersion testing, bonded fitting performance is considered favorable.

MIL-D-53092 - 500-Gallon Drum

Except for a low liner hardness, the initial and heat-aged properties of the candidate 500-gallon drum materials were within the limits specified in MIL-D-53092 (see Table 5). Conforming results were also obtained for fuel and oil immersion and ozone resistance. Fuel permeability was excessive and considerably greater than that reported by Amfuel, as was the compression set of the liner. Compression set of the cover material and washed gum residue were satisfactory and in close agreement with data cited by Amfuel. The adhesion between cord plies and between the cover and cord plies was adequate initially and after fuel immersion, but failures were recorded for the liner/cord interface in both cases. Puncture resistance was not measured due to inability to obtain the proper specimens.

MIL-H-53095 - Collapsible Fuel Hoses

Gates Hoses

Data for the two lots of MIL-H-53095 hose submitted by Gates Rubber Company are summarized in Table 6. The first lot consisted of only the 1-1/2- and 4-inch sizes while all requested sizes were included in the second lot. It is assumed that all sizes within a specific lot were made from the same compounds. The nature of any mixing or fabrication modifications employed in preparation of the second lot are unknown. Agreement between ARL and Gates results for initial tensile strength and elongation was generally good, as was conformance to the specification requirements.

Obviously, no direct comparison can be made between ARL and Gates results for volume change since Gates data are based on Reference Fuel B rather than JP-8. The latter fuel is not readily available for use by industry. Tube compounds from both lots displayed 30% swelling in JP-8 while, as would be expected, corresponding Gates (Fuel B) values were consistently higher and somewhat more variable (ranging from 42% to 65%). Again, ARL/JP-8 results for volume change of the cover compound are consistent and within limits while Gates values vary considerably between lots. Propylene oxide, the base rubber used for the cover, is not a fuel-resistant elastomer, thus explaining the high swelling in Fuel B as recorded by Gates, particularly for the second lot of hose.

Immersion of the tube and over compounds for 48 hours in either ARL's JP-8 or Gates' Fuel B produced conformance to elongation retention requirements in all cases. Retention of tensile strength was inconsistent with failures noted. Instances were observed where better retention was observed for the cover or retention after JP-8 immersion was poorer than that found for exposure to Fuel B. Rather than elucidate, it is apparent that performance of both the tube and the cover is, at best, marginal.

Assessment of pre- and post-immersion adhesion between layers comprising the hose structure is complicated by several cited instances of tearing or ply separation during testing. In most cases, tearing can be attributed to difficulties encountered in initiating a separation because of the effectiveness of "strike through" during hose fabrication. All instances of delamination were reported by Gates and occurred between the ply and the tube after Fuel B immersion. Corresponding ARL/JP-8 results were lower than those obtained for cover/ply and ply/ply separation. Since it is known that the bonding of two different elastomeric compounds can be difficult, these adhesion results are considered fair to good.

Fuel-extracted specimens of both the tube and cover materials passed the brittleness test after exposure at -60°F. Gates reported single values for the modulus of elasticity of the tube and cover; apparently, as determined using specimens taken from test slab material rather than each hose. Tube moduli recorded by ARL were lower while cover moduli were higher than those cited by Gates. All ARL and Gates tube modulus values met the specification requirements. The modulus of all cover specimens taken from the second lot and tested by ARL exceeded the allowable maximum.

Variations in the washed gum content were recorded by both ARL and Gates for the different hose sizes evaluated with some failures noted. ARL analysis of a fuel specimen furnished by Gates produced a conforming value of 5.0 mg/ml. which was within specification limits. No failures were observed in the remaining qualification tests conducted, i.e., hose weight and ozone resistance.

Goodyear Hoses

Prototype lengths of all sizes of MIL-H-53095 hoses were provided for evaluation with ARL results summarized in Table 7. Corresponding Goodyear data consists of a single composite average for all sizes. Here again, supplier fuel immersion data reflects performance in Reference Fuel B. Except for a high initial tube elongation reported by Goodyear, original tensile strength and elongation values are fairly consistent and within specification limits. Volume change data are somewhat anomalous in that Goodyear reported lower tube swelling in Fuel B than was recorded by ARL using JP-8. ARL data for swelling of the cover was marginal while the 145% cited by Goodyear appears to be more than would be expected, even for the higher aromatic content Fuel B.

Retention of tensile strength and elongation after fuel immersion was acceptable for the tube component. The low (34%) tensile retention reported by Goodyear is again attributable to the use of Fuel B. Corresponding values for the cover were poor; all specimens tested did not retain adequate tensile strength, and the decrease in elongation was rather severe when contrasted with the high initial values.

The problems encountered with the Gates candidate hoses in obtaining valid pre- and post-immersion adhesion values surfaced again but no incidents of delamination were reported by ARL or Goodyear. In all cases where values were obtained, they were acceptable. The only exception was a post-immersion figure of 1.5 pounds for the ply/tube interface (using Fuel B) noted in the Goodyear data.

The Goodyear hose materials satisfied specification requirements for ozone resistance and displayed no brittleness at -60°F. Modulus of elasticity of the hose cover after fuel extraction was within specification limits, while that of the tube slightly exceed the realistic maximum value of 10,000 psi. Goodyear reported conformance to the heptane-washed gum requirement of <5 mg/100 ml, but three of the four values obtained by ARL exceeded that limit.

MIL-H-53096 - Noncollapsible Hoses

Gates Hoses

Arctic Forward Area Refueling Equipment requirements for noncollapsible (discharge) hoses are limited to those of 2, 3, and 6 inches in diameter. Prototype lengths of all three

sizes were supplied by Gates for evaluation. ARL and Gates data is contained in Table 8. Reasonable agreement among reported conforming values for original tensile strength of the tube and cover was obtained while significant discrepancies were evident in the corresponding elongation data. ARL recorded lower values for both tube and cover with several failures noted.

The U.S. Army Research Laboratory volume change data, using JP-8, indicated conformance of both the tube and the cover while Gates values, based on Reference Fuel B, denoted higher swelling and nonconformance of the cover. Elongation retention after immersion was satisfactory in all cases. Results for retention of tensile strength were somewhat anomalous and inconsistent. Tube failures were observed in four of the six ARL/Gates tests conducted while Gates reported significantly higher cover retention even though Fuel B was used. Here, only the 6-inch hose cover passed in ARL testing. Performance of the non-fuel resistant cover was better than expected.

Again, the adhesion results are difficult to interpret due to incidences of tearing and delamination, as well as difficulty in removing the wire reinforcement from the 6-inch hose. In all cases except one (Gates, 6 inch), the reported values, both initially and after immersion, were acceptable but the ARL result for post-immersion ply/tube adhesion was marginal.

Both the tube and cover passed all -60^{o}F brittleness tests. Neither ARL or Gates conducted a separate modulus of elasticity test on this hose with the latter reporting the same values given for the collapsible hose.

Goodyear Hoses

Data supplied by Goodyear for the noncollapsible hoses again consisted of composite averages for the three sizes under consideration with Reference Fuel B being used in lieu of JP-8. ARL results are for the 2- and 3-inch sizes, plus another 3 inch so-called experimental hose. Initial tensile strength and elongation data evidenced no instances of non-conformance with the only recorded outlier being the seemingly high 730% cover elongation claimed by Goodyear. Volume change of the tube was acceptable while that of the cover was marginal for the 3 inches and beyond the specified limit for all others, including the single Goodyear value of 145% (Fuel B). Retention of tensile strength of the tube after JP-8 immersion was favorable in ARL testing and below minimum 40% according to Goodyear (based on usc of Fuel B). All cover specimens failed this test. Elongation retention of both the tube and cover was within limits.

Numerous instances of tearing during adhesion testing were recorded. All reported values were high (30 ppiw) except for failures registered by Goodyear subsequent to fuel immersion. Assuming that problems encountered were due to strong bonding between layers, adhesion is considered acceptable.

Low temperature properties; brittleness and modulus of elasticity, were satisfactory although Goodyear reported a modulus which was more than twice that cited by ARL. Of the remaining properties evaluated; washed gum, weight, crush resistance and recovery, and ozone resistance, the only failure noted was the low (64%) crush resistance of the experimental hose.

Conclusions

MIL-T-53101 Tank Components

Bell Avon's fabric coating compound performed poorly in several of the fuel and water immersion tests conducted by ARL. Particularly significant is the large decrease in properties of fuel-extracted specimens after 42 days exposure in JP-8, indicative of susceptibility to leaching out of ultra-violet stabilizers and probable accelerated degradation. This, combined with excessive stiffening at -60°F, is indicative of, at best, marginal acceptance.

The single-coated fabric proposed by Bell Avon for fabrication of 3K-, 10K-, and 20K-gallon tanks failed to satisfy the breaking strengths requirement for the 20K size in ARL testing and did not pass the initial Fuel B diffusion test. Conformance to all other MIL-T-53101 requirements was attained.

As determined by ARL, the Bell Avon-furnished seams failed the 20K-gallon tank requirements for initial breaking strength, initially, and after the 14 day extraction/immersion procedure. Seam peel values subsequent to similar aging were also below those cited for all three sizes. However, good performance after the 42-day exposure is indicative of adequate resistance to degradation caused by leaching out of urethane stabilizers.

The U.S. Army Research Laboratory results for initial breaking strength of bonded fittings were in disagreement with those provided by Bell Avon. Otherwise, except for a low peel adhesion after the 14 day JP-8 extraction/immersion, all other specification criteria were satisfied.

500-Gallon Drum

The Amfuel candidate drum material did not satisfy all MIL-D-53092 requirements; displaying low hardness and high compression set of the liner compound. Additionally, liner/cord adhesion initially and after JP-8 immersion was poor. Fuel permeability, as measured by ARL, was excessive and should be checked further before acceptance.

Collapsible Hoses

The fuel resistance and adhesion properties of the Gates hoses were inconsistent with some failures; particularly of the cover compound observed. Most of the ply adhesion failures were attributable to tearing rather than weak bonding. Thus, these hoses are considered marginally acceptable as an AFARE component.

Because of the extremely poor fuel resistance of the cover compound, Goodyear hoses are not recommended for inclusion in the proposed AFARE system.

Noncollapsible Hoses

Comments regarding the fuel resistance for the Gates' collapsible hoses are also applicable to these hoses. Ply adhesion, where measurable, was satisfactory. Poor initial elongation; particularly of the cover, warrants further testing. Over-all performance is indicative of consideration in the AFARE program.

Again, failure of the cover compound of Goodyear hoses to conform target requirements for fuel resistance disqualifies them for further consideration as an AFARE component.

Table 1. MIL-T-53101 - Arctic fuel tank properties of coating compound

PROPERTY	MIL-T-53101 REQUIREMENTS	TEST METHOD OR PAR. NO.		ARL RESULTS
ORIGINAL PROPERTIES				
TENSILE STRENGTH, PSI.	1500 (MIN)	ASTM D 412		3480
ULTIMATE ELONGATION, %	300 (MIN)	ASTM D 412		680
PROPERTIES AFTER IMMERSION IN JP-8 @ 160F FOR 14 DAYS				
TENSILE STRENGTH RETAINED, %	80% (MIN)	ASTM D 471/	F	48
ELONGATION RETAINED, %	80% (MIN)	ASTM D 412		99
VOLUME SWELL, %	25% (MAX)	ASTM D 471	F	41
PROPERTIES AFTER IMMERSION IN FUEL B @ 160F FOR 14 DAYS				
TENSILE STRENGTH RETAINED, %	80% (MIN)	ASTM D 471/	F	74
ELONGATION RETAINED, %	80% (MIN)	ASTM D 412		108
VOLUME SWELL, %	25% (MAX)	ASTM D 471	F	32
PROPERTIES AFTER JP-8 EXTRACTION AND IMMERSION IN WATER @ 160F FOR 14 DAYS				
TENSILE STRENGTH RETAINED, %	75% (MIN)	ASTM D 471/	M	74
ELONGATION RETAINED, %	80% (MIN)	ASTM D 412		103
VOLUME SWELL, %	10% (MAX)	4.5.2.22	F	17
42 DAYS				
TENSILE STRENGTH RETAINED, %	70% (MIN)	ASTM D 471/	F	39
ELONGATION RETAINED, %	75% (MIN)	ASTM D 412	M	72
VOLUME SWELL, %	10% (MAX)	4.5.2.22	F	58
PROPERTIES AFTER IMMERSION IN WATER @ 160F FOR:				
14 DAYS				
TENSILE STRENGTH RETAINED, %	75% (MIN)	ASTM D 471/	F	58
ELONGATION RETAINED, %	80% (MIN)	ASTM D 412		101
VOLUME SWELL, %	10% (MAX)			4
42 DAYS				
TENSILE STRENGTH RETAINED, %	70% (MIN)	ASTM D 471/		—
ELONGATION RETAINED, %	75% (MIN)	ASTM D 412		—
VOLUME SWELL, %	10% (MAX)			—
RESISTANCE TO LIGHT AFTER 1500 HRS ACCEL. WEATHERING @ 10% ELONGATION		ASTM D 750/ ASTM D 2565		
TENSILE STRENGTH RETAINED, %	80% (MIN)			NO TEST
FUEL CONTAMINATION: JP-8				
HEPTANE WASHED GUM, MG/100ML	5 (MAX)	4.5.2.1.1		1.0
OZONE RESISTANCE	NO CRACKS UNDER 7X MAGNIFICATION	ASTM D 1149 TYPE A SPECIMENS		PASS
LOW TEMPERATURE PROPERTIES CONDITIONED 94 HRS @ -60F				
"G" MODULUS OF RIGIDITY	100,000 PSI (MAX.)	ASTM D 1053 TYPE B SPECIMENS		31823
BRITTLENESS	NO CRACKING	ASTM D 746		PASS

F = Failure
M = Marginal

Table 2. MIL-T-53101 - Arctic fuel tank properties of coated fabric

COATED FABRIC PROPERTY	MIL-T-53101 REQUIREMENTS	ASTM/FTMS 191 METHOD OR PAR. NO.	ARL RESULTS	BELL AVON RESULTS
	3K/10K/20K GAL			
WEIGHT, (OZ/SQ YD)	30 MIN, 62 MAX	191/5041	33.7	33.4
DIFFUSION RATE, JP-8 FL OZ/SQ FT/24 HR, MAX.	.12/.12/.12	4.5.2.1.5	0.052	—
DIFFUSION RATE, FUEL-B FL OZ/SQ FT/24 HR, MAX.	.12/.12/.12	4.5.2.1.5	F 0.266	—
TEAR STRENGTH, WARP/FILL LB., MINIMUM	25/25/35	191/5134	40/40	62/44
BREAKING STRENGTH WARP/FILL, LB/IN, MIN	350/350/500	191/5102	* 469/441	744/611
PUNCTURE RESISTANCE LBS., MINIMUM	110/110/150	191/5120	154	204
WEATHERING RESISTANCE, 1500 HRS AT 5% ELONG.		191/5804/5102 ASTM D 2565		
BREAKING STRENGTH RETENTION - WARP/FILL, %, MIN.	80/80/80		—	90
LOW TEMPERATURE CREASE RESISTANCE	NO CRACKS OR DELAMINATION UNDER 7X LENS	4.5.2.1.5		
APPEARANCE AFTER UNFOLDING			PASSED	PASSED
DIFFUSION RATE, JP-8 FL OZ/SQ FT/24 HRS, MAX	.3/.3/.3	4.5.2.1.2	0.018	—
DIFFUSION RATE, FUEL B FL OZ/SQ FT/24 HRS, MAX	.3/.3/.3	4.5.2.1.2	—	0.2921
FUNGUS RESISTANCE APPEARANCE	NO CRACKS, BLISTERS, OR DELAMINATION OF COATING	191/5762	NO TEST	—
BREAKING STRENGTH RETAINED WARP & FILL, %, MIN	80/80/80	191/5102	NO TEST	99
BLOCKING	SEPARATION IN 5 SECONDS	4.5.2.16	PASSED	PASSED
COATING ADHESION INITIAL, LB/IN, MIN	20/20/20	4.5.2.17 4.5.2.17.1	81	92
AFTER FUEL IMMERSION, JP-8 FOR 14 DAYS AT 160 F LB/IN, MIN	10/10/10	ASTM D 471 (15.2) 4.5.2.17 4.5.2.17.1	48	** 37
AFTER FUEL EXTRACTION, JP-8 DRIED, AND IMMERSED IN WATER AT 160 F FOR: 14 DAYS, LB/IN, MIN	10/10/10	ASTM D 471 (15.2) 4.5.2.17 4.5.2.17.1 4.5.2.22	26	—
42 DAYS, LB/IN, MIN	8/8/8	• • •	15	—

* = Failed 20 K Requirement

** = Fuel B

Table 3. MIL-T-53101-Arctic fuel tank properties of seams

SEAM PROPERTY		MIL-T-53101 REQUIREMENTS	ASTM/FTMS 191 METHOD OR PAR. NO.		ARL RESULTS
		3K, 10K,20K GAL.			
BREAKING STRENGTH INITIAL, LB/IN, MIN	SM	380/380/500	ASTM D 751,METH. B 4.5.2.18	*	437
AFTER IMMERSION IN JP-8 FOR 14 DAYS @ 160 F	SM	280/280/400	ASTM D 751,METH. B ASTM D 471 (15.2) 4.5.2.18		408
AFTER IMMERSION IN WATER FOR 14 DAYS @ 160 F	SM	280/280/400	. . .		408
AFTER FUEL EXTRACTION, JP-8 DRIED, AND IMMERSION IN DISTILLED WATER AT 160 F FOR			ASTM D 751,METH. B ASTM D 471 (15.2) 4.5.2.18, 4.5.2.22		
14 DAYS, LB/IN, MIN	SM	280/280/400		*	372
42 DAYS, LB/IN, MIN	SM	280/280/400			408
AFTER FUEL-B EXTRACTION DRIED, AND IMMERSION IN DISTILLED WATER AT 160 F FOR:			ASTM D 751,METH. B ASTM D 471 (15.2) 4.5.2.18, 4.5.2.22		
14 DAYS, LB/IN, MIN	SM	325/325/450		*	388
42 DAYS, LB/IN, MIN	SM	325/325/450		*	404
DEAD LOAD SHEAR RESISTANCE UNDER 60 LB/IN STRESS AT 160 F FOR 8 HOURS		0.125 IN SLIP. (MAX)	4.5.2.18		Passed, No Slippage
SEAM PEEL ADHESION INITIAL, LB/IN, MIN	EC		ASTM D 413, MACH. METH 4.5.2.18		—
	SM	30/30/30			94
	FF				—
	HP				—
	CP				—
AFTER IMMERSION IN JP-8 FOR 14 DAYS AT 160 F LB/IN, MIN	EC		ASTM D 413, MACH. METH ASTM D 471 (15.2) 4.5.2.18		46
	SM	20/20/20			46
	FF				47
	HP				46
	CP				38
AFTER IMMERSION IN FUEL B FOR 14 DAYS AT 160 F LB/IN, MIN	EC		ASTM D 413, MACH. METH ASTM D 471 (15.2) 4.5.2.18		34
	SM	20/20/20			50
	FF				50
	HP				44
	CP				24
AFTER WATER IMMERSION FOR 14 DAYS AT 160 F LB/IN, MIN	EC		ASTM D 413, MACH. METH ASTM D 471 (15.2) 4.5.2.18		68
	SM	20/20/20			71
	FF				73
	HP				74
	CP				FAILED
AFTER WATER IMMERSION FOR 42 DAYS AT 160 F LB/IN, MIN	EC		ASTM D 413, MACH. METH ASTM D 471 (15.2) 4.5.2.18		52
	SM	15/15/15			54
	FF				56
	HP				53
	CP				38
AFTER JP-8 EXTRACTION, DRIED, AND IMMERSION IN DISTILLED WATER AT 160 F FOR:			ASTM D 413, MACH. METH. ASTM D 471 (15.2) 4.5.2.18, 4.5.2.22		
14 DAYS, LB/IN, MIN	SM	20/20/20		**	14
42 DAYS, LB/IN, MIN	SM	15/15/15			15
AFTER FUEL-B EXTRACTION DRIED, AND IMMERSION IN DISTILLED WATER AT 160 F FOR:			ASTM D 413, MACH. METH. ASTM D 471 (15.2) 4.5.2.18, 4.5.2.22		
14 DAYS, LB/IN, MIN	SM	20/20/20		**	15
42 DAYS, LB/IN, MIN.	SM	15/15/15			15

** = Failed 20 K Requirement*
*** = Failed 3, 10, & 20 K Requirement*

SM = Typical Seam　　FF = Flange Fitting　　CP = Chafing Patch
EC = End Closure　　HP = Handle Patch

Table 4. MIL-T-53101 - Arctic fuel tank properties of bonded fittings

FITTING PROPERTY		MIL-T-53101 REQUIREMENTS	ASTM/FTMS 191 METHOD OR PAR. NO.		ARL RESULTS
		3K, 10K,20K GAL			
ALUMINUM TO COATED FABRIC	AC		4.5.2.20	**	374
BOND, BREAKING STRENGTH,	VD		4.5.2.20.1	**	329
INITIAL, LB/IN, MIN	AS	400/400/550		**	324
AFTER IMMERSION IN JP-8	AC		ASTM D 471 (15.2)		571
AT 160 F	VD		4.5.2.20		458
FOR 14 DAYS, LB/IN, MIN	AS	290/290/400	4.5.2.20.1		781
AFTER IMMERSION IN FUEL B	AC		ASTM D 471 (15.2)		516
AT 160 F	VD		4.5.2.20		537
FOR 14 DAYS, LB/IN, MIN	AS	290/290/400	4.5.2.20.1		638
AFTER IMMERSION IN WATER	AC		ASTM D 471 (15.2)		—
AT 160 F	VD		4.5.2.20		539
FOR 14 DAYS, LB/IN, MIN	AS	290/290/400	4.5.2.20.1		524
AFTER IMMERSION IN WATER	AC		ASTM D 471 (15.2)		666
AT 160 F	VD		4.5.2.20		—
FOR 42 DAYS, LB/IN, MIN	AS	290/290/400	4.5.2.20.1		781
AFTER EXTRACTION IN JP-8,					
DRIED, AND IMMERSION IN	AC		ASTM D 471 (15.2)		—
DISTILLED WATER @ 160 F	VD		4.5.2.20, 4.5.2.20.2		—
FOR 14 DAYS, LB/IN, MIN	AS	325/325/450	4.5.2.22		—
	AC		ASTM D 471 (15.2)		—
42 DAYS, LB/IN, MIN	VD	290/290/400	4.5.2.20, 4.5.2.20.2		—
	AS		4.5.2.22		—
DEAD LOAD SHEAR RESISTANCE					
UNDER 60 LB/IN. STRESS AT			4.5.2.19		
180 F FOR 8 HOURS		0.125 IN. SLIP (MAX)	4.5.2.20.3		PASS
PEEL ADHESION OF ALUMINUM					
STRIP TO COATED FABRIC			ASTM D 429, METH> B		
INITIAL, LB/IN, MIN		30/30/30	4.5.2.21		0
AFTER IMMERSION IN JP-8			ASTM D 429, METH. B		
FOR 14 DAYS AT 160 F			ASTM D 471 (15.2)		
LB/IN, MIN		20/20/20	4.5.2.21		0
AFTER EXTRACTION IN JP-8,			ASTM D 429, METH. B		
DRIED, AND IMMERSION IN			ASTM D 471 (15.2)		
DISTILLED WATER AT 160 F			4.5.2.21,4.5.2.22		
FOR:					
14 DAYS, LB/IN, MIN		20/20/20		**	6
42 DAYS, LB/IN, MIN		15/15/15			0

* = Failed 20 K Requirement
** = Failed 3, 10, & 20 K Requirement

AC = Access Fitting-Curved AS = Access Fitting-Straight
VD = Vent Drain Fitting

Table 5. MIL-D-53092 - 500-Gallon Drum ARL/AMFUEL Results

PROPERTY	REQUIREMENT	TEST PROC. OR PAR. NO.	ARL RESULTS	AMFUEL RESULTS
TENSILE STRENGTH, COVER, PSI	1500 Min.	ASTM D 412	1803	1642
TENSILE STRENGTH, LINER, PSI	1500 Min.	ASTM D 412	2060	1789
ELONGATION, COVER, %	250 Min.	ASTM D 412	280	325
ELONGATION, LINER, %	250 Min.	ASTM D 412	467	450
HARDNESS, COVER, PTS	55-65	ASTM D 2240	65	58
HARDNESS, LINER, PTS	55-65	ASTM D 2240	50 F	61
HEAT RESISTANCE - 70 HOURS AT 100 C				
TENSILE STRENGTH CHANGE, COVER, %	-20 Max.	ASTM D 573	2	3
TENSILE STRENGTH CHANGE, LINER, %	-20 Max.	ASTM D 573	1	8.1
ELONGATION CHANGE, COVER, %	-40 Max.	ASTM D 573	—	-4.5
ELONGATION CHANGE, LINER, %	-40 Max.	ASTM D 573	—	-10
HARDNESS CHANGE, COVER, PTS	15 Max.	ASTM D 573	—	3
HARDNESS CHANGE, LINER, PTS	15 Max.	ASTM D 573	—	7
FUEL IMMERSION - 70 HOURS AT 23 C IN JP-8				
VOLUME CHANGE, LINER, %	50 Max.	ASTM D 471	17	(1) 21
OIL IMMERSION - 70 HOURS AT 100 C IN ASTM OIL NO. 3				
VOLUME CHANGE, LINER, %	50 Max.	ASTM D 471	13	2.3
VOLUME CHANGE, COVER, %	120 Max.	ASTM D 471	68	9.4
OZONE RESISTANCE -7 DAYS AT 40 C 50mPa AND 20% ELONGATION				
LINER	No Cracks	ASTM D 1149	PASS	PASS
COVER	No Cracks	ASTM D 1149	PASS	PASS
FUEL PERMEABILITY, FL OZ/SQ FT/ 24 HOURS	1.5 Max.	ASTM D 814/ 4.5.2.1.1	24 F	0.78
COMPRESSION SET				
LINER, %	50% Max.	ASTM D 395	96 F	23
COVER, %	80% Max.	ASTM D 395 4.5.2.1.2	39	40.1
FUEL CONTAMINATION HEPTANE WASHED EXISTENT GUM, MG/100 ML	7 mg. Max.	ASTM D 381/ 4.5.2.1.3	0.5	2.2
ADHESION				
BETWEEN CORD PLIES, LB/IN	10 pprw Min.	ASTM D 751	31	17
BETWEEN LINER AND CORD, LB/IN	10 pprw Min.	ASTM D 751	6.5 F	13
BETWEEN COVER AND CORD, LB/IN	10 pprw Min.	ASTM D 751	20	13
ADHESION AFTER IMMERSION FOR 70 HOURS AT 23 C IN JP-8				
BETWEEN CORD PLIES, LB/IN	5 pprw Min.	ASTM D 751	13	—
BETWEEN LINER AND CORD, LB/IN	5 pprw Min.	ASTM D 751	1 F	—
BETWEEN COVER AND CORD, LB/IN	5 pprw Min	ASTM D 751	6	—
PUNCTURE RESISTANCE-LBS.	200 lbs. Min	4.5.2.1.4	—	387

(1) - Results for Ref. Fuel B

Table 6. MIL-H-53095 - Collapsible hoses ARL/Gates results

PROPERTY	REQUIREMENTS	MIL-H-53095 PAR. NO	GATES (1) RESULTS				GATES (2) RESULTS							
			1.5-ARL	1.5-Gates	4"-ARL	4"-Gates	1.5-ARL	1.5-Gates	2-ARL	2-Gates	3-ARL	3-Gates	4-ARL	4-Gates
ORIGINAL PROPERTIES														
TENSILE STRENGTH, PSI.														
TUBE	1250 psi MIN	4.5.2.3	1646	1408	2463	1646	2136	2230	2184	2243	2171	2310	1868	1672
COVER	1000 psi MIN	4.5.2.3	1406	1524	1635	1306	1188	1163	1177	1022	1317	1177	1342	1145
ELONGATION, %														
TUBE	200% MIN	4.5.2.3	480	562	500	683	518	630	542	628	613	618	537	580
COVER	200% MIN	4.5.2.3	288	364	330	358	313	367	303	312	361	288	318	338
VOLUME CHANGE, AFTER IMMERSION IN JP-8 FOR 48 hrs @ RT (1)														
TUBE	60%, MAX	4.5.2.4	30	42	30	48	30	56	30	56	31	58	33	65 F
COVER	100%, MAX	4.5.2.4	78	23	83	78	85	128 F	83	128 F	86	118 F	84	114 F
TENSILE AND ELONGATION AFTER IMMERSION IN JP-8 FOR 48hrs @ RT (1)														
TENSILE STRENGTH, TUBE, PSI	800psi/40%	4.5.2.4	821/50	844/46	852/35 F	784/48	866/41	758/34 F	883/48	878/44	941/43	1150/50	778/40	812/37 F
ELONGATION, TUBE, %	100% (MIN)	4.5.2.4	325	327	308	411	321	285	348	330	347	352	281	286
TENSL. STRENGTH,COVER, PSI	800psi/40%	4.5.2.4	817/44	873/57	818/38 F	840/70	441/37 F	733/63	482/41 F	807/58	512/30 F	853/58	477/28 F	842/47 F
ELONGATION, COVER, PSI	100% (MIN)	4.5.2.4	155	168	182	180	161	178	157	156	163	164	148	134
ORIGINAL ADHESION														
BETWEEN COVER AND PLY	10 ppiw	4.5.2.5	(2)	23	(2)	20	(2)	30	(2)	22	(2)	32	(2)	28
BETWEEN PLIES	10 ppiw	4.5.2.5	18	27	15	28	37	58	27	41	38	60	32	37
BETWEEN PLY AND TUBE	10 ppiw	4.5.2.5	(2)	7 F	(2)	17	(2)	27	(2)	25	18	28	(2)	8 F
ADHESION AFTER IMMERSION IN JP-8, 48 hrs. @ RT (1)														
BETWEEN COVER AND PLY	8 ppiw	4.5.2.8	(2)	(2)	(2)	13	(2)	(2)	(2)	14	(2)	(2)	26	10
BETWEEN PLIES	8 ppiw	4.5.2.8	(2)	12	14	11	22	18	20	14	28	14	28	10
BETWEEN PLY AND TUBE	8 ppiw	4.5.2.8	7	(3)	7	(3)	11	3 F	13	3 F	13	(3)	12	(3)
BRITTLENESS, -40 F, AFTER FUEL EXTRACTION														
TUBE	NONE	4.5.2.7.1	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
COVER	NONE	4.5.2.7.1	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
MODULUS OF ELASTICITY, -40 F AFTER FUEL EXTRACTION														
TUBE	< 100,000 psi	4.5.2.7.2	---	42000	---	42000	20411	42000	13453	42000	15664	42000	13778	42000
COVER	< 5,000 psi	4.5.2.7.2	---	3300	---	3300	5583	3300	8071	3300	5121	3300	5283	3300
HEPTANE WASHED GUM	< 5mg/100ml	4.5.2.8	----	8.4 F	9.0 F	9.8 F	36 F	8.4 F	23 F	25.4 F	21 F	3	13 F	1.8
WEIGHT, Lbs/Ft	1/1.125/1.75/2.5	-----	0.5	0.5	1.5	1.3	0.5	---	0.8	---	1.1	---	1.4	
OZONE RESISTANCE 72 HR., 50 PPHM	NO CRACKS @ 7X	4.5.2.10	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS

F Failure (1) - Gates Results Based on Ref. Fuel B (3) - Specimens Delaminated
M Marginal (2) - Specimens Tore

Table 7. MIL-H-53095 - Collapsible hoses ARL/Goodyear results

PROPERTY	REQUIREMENTS	MIL-H-53095 PAR. NO.	ARL Results 1.5	2"	3"	4"	Goodyear Results (2)
ORIGINAL PROPERTIES							
TENSILE STRENGTH, PSI.							
TUBE	1250 psi MIN	4.5.2.3	3147	2737	3171	3319	3360
COVER	1000 psi MIN	4.5.2.3	1677	1750	1883	1728	1850
ELONGATION, %							
TUBE	200% MIN	4.5.2.3	410	387	418	399	527
COVER	200% MIN	4.5.2.3	708	663	781	657	730
VOLUME CHANGE, 48 hrs IN JP-8, RT							
TUBE (1)	60%, MAX	4.5.2.4	36	38	28	29	27
COVE (1)	100%, MAX	4.5.2.4	105 F	99 M	102 M	103 M	145
TENSILE AND ELONGATION AFTER IMMERSION IN JP-8 FOR 48hrs @ RT (1)							
TENSILE STRENGTH, TUBE, PSI	600psi/40%	4.5.2.4	1382/44	1296/47	1285/41	1693/51	1155/34 F
ELONGATION, TUBE, %	100% (MIN)	4.5.2.4	249	254	225	254	260
TENSILE STRENGTH,COVER, PSI	600psi/40%	4.5.2.4	363/22 F	241/14 F	146/8 F	259/15 F	465/25 F
ELONGATION, COVER, PSI	100% (MIN)	4.5.2.4	235	118	111 M	192	163
ORIGINAL ADHESION							
BETWEEN COVER AND PLY	10 ppiw	4.5.2.5	(3)	(3)	(3)	(3)	30.2
BETWEEN PLIES	10 ppiw	4.5.2.5	29	29	38	45	44 9
BETWEEN PLY AND TUBE	10 ppiw	4.5.2.5	(3)	45	65	(3)	50.5
ADHESION AFTER IMMERSION IN JP-8, 48 hrs. @ RT (1)							
BETWEEN COVER AND PLY	6 ppiw	4.5.2.6	(3)	(3)	(3)	40	(3)
BETWEEN PLIES	6 ppiw	4.5.2.6	23	30	28	31	10.6
BETWEEN PLY AND TUBE	6 ppiw	4.5.2.6	(3)	(3)	24	15	1.5
BRITTLENESS, -60 F, AFTER FUEL EXTRACTION							
A) TUBE	NONE	4.5.2.7.1	PASS	PASS	PASS	PASS	PASS
B) COVER	NONE	4.5.2.7.1	PASS	PASS	PASS	PASS	PASS
MODULUS OF ELASTICITY, -60 F AFTER FUEL EXTRACTION							
A) TUBE	<100,000 psi	4.5.2.7.2	10970	8898	19264	16425	19650
B) COVER	<5,000 psi	4 5.2.7.2	439	423	597	469	4646
HEPTANE WASHED GUM	<5mg/100ml	4.5.2.8	7 F	9 F	14 F	5	1.75
WEIGHT, Lbs/Ft.	1/1.125/1.75/2.5	—	0.5	0.7	1.0	1.5	—
OZONE RESISTANCE 72 HR., 50 PPHM	NO CRACKS @ 7X	4.5.2.10	PASS	PASS	PASS	PASS	—

F - Failure
M - Marginal
(1) - Goodyear Results Based on Fuel B
(2) - Average for Four Sizes
(3) - Specimens Tore

Table 8. MIL-H-53096 - Non-collapsible hoses ARL/Gates results

PROPERTY	REQUIREMENTS	MIL-H-53095 PAR. NO.	2-ARL	2-Gates	3-ARL	3-Gates	6-ARL	6-Gates
ORIGINAL PROPERTIES								
TENSILE STRENGTH								
TUBE, psi.	1250 psi, MIN	4.5.2.3	2752	2520	2415	2468	1979	2340
COVER, psi.	1000 psi, MIN	4.5.2.3	1198	1117	1324	1000 M	1521	1335
ELONGATION								
TUBE, %	200%, MIN	4.5.2.3	229	650	241	621	133 F	673
COVER, %	200%, MIN	4.5.2.3	142 F	353	187 F	291	189 F	409
VOLUME CHANGE, AFTER IMMERSION IN JP-8 FOR 70 hrs @ RT (1)								
TUBE, %	60%, MAX	4.5.2.4	31	50	30	49	31	52
COVER, %	100%, MAX	4.5.2.4	86	116 F	86	109 F	85	115 F
TENSILE AND ELONGATION RETENTION AFTER IMMERSION IN JP-8 (1) FOR 70 hrs @ RT								
TUBE, TEN. STR./% RET.	600psi/40%	4.5.2.4	1015/37 F	859/34 F	1050/43	925/37 F	1043/59	861/37 F
ELONGATION, %	100% (MIN)	4.5.2.4	320	334	337	300	223	319
COVER, TEN. STR./% RET.	600psi/40%	4.5.2.4	525/44 F	725/65	574/43 F	628/63	619/45	773/58
ELONGATION, %	100% (MIN)	4.5.2.4	189	175	168	154	160	185
ORIGINAL ADHESION								
BETWEEN COVER AND PLY	10 ppiw	4.5.2.5	25	31	28	33	(3)	—
BETWEEN PLIES	10 ppiw		31	63	(2)	49	(3)	—
BETWEEN PLY AND TUBE	10 ppiw		(2)	32	27	24.	(3)	—
ADHESION AFTER IMMERSION IN JP-8, 70 hrs. @ RT (1)								
BETWEEN COVER AND PLY	6 ppiw	4.5.2.6	25	(2)	(2)	(2)	(3)	(2)
BETWEEN PLIES	6 ppiw		25	10	43	16	(3)	16
BETWEEN PLY AND TUBE	6 ppiw		25	6 M	37	(4)	(3)	3 F
BRITTLENESS, -60 F, AFTER FUEL EXTRACTION								
TUBE	NONE	4.5.2.7.1	PASS	PASS	PASS	PASS	PASS	PASS
COVER	NONE		PASS	PASS	PASS	PASS	PASS	PASS
MODULUS OF ELASTICITY, -60 F AFTER FUEL EXTRACTION								
TUBE	<100,000 psi	4.5.2.7.2	—	42000	—	42000	—	42000
COVER	<5,000 psi		—	3300	—	3300	—	3300
HEPTANE WASHED GUM	6 mg/100 ml MAX		14 F	2.6	19 F	28	—	2
WEIGHT, Lbs/Ft.	1.3/2.0/5.75	———	1.3	1.25	2.1	2.1	4.6	5.35
CRUSH RESISTANCE, @ spec. load,	85% Orig. O.D.	4.5.2.9	87	—	86	—	93	—
CRUSH RECOVERY, no load, %	98% Orig. O.D.	4.5.2.9	96	—	96	—	99	—
OZONE RESISTANCE 72 HR., 50 PPHM	NO CRACKS	4.5.2.10	PASS	PASS	PASS	PASS	PASS	PASS

F - Failure
M - Marginal
(1) - Gates Results Based on Ref. Fuel B
(2) - Specimens Tore
(3) - Could Not Remove Wire
(4) - Specimens Delaminated

Table 9. MIL-H-53096 - Non-collapsible hoses ARL/Goodyear results

PROPERTY	REQUIREMENTS	MIL-H-53096 PAR. NO.	ARL Results 2"	3"	EXP	Goodyear Results (2)
ORIGINAL PROPERTIES						
TENSILE STRENGTH						
TUBE, psi.	1250 psi, MIN	4.5.2.3	3397	2417	4473	3360
COVER, psi.	1000 psi, MIN	4.5.2.3	1693	1866	1868	1850
ELONGATION						
TUBE, %	200%, MIN	4.5.2.3	286	233	400	527
COVER, %	200%, MIN	4.5.2.3	296	226	376	730
VOLUME CHANGE, 70 hrs IN JP-8, RT						
TUBE, % (1)	60%, MAX	4.5.2.4	25	38	42	27
COVER, % (1)	100%, MAX	4.5.2.4	102 M	106 F	110 F	145 F
TENSILE AND ELONGATION RETENTION AFTER IMMERSION IN JP-8 FOR 70 hrs @ RT						
TUBE, TEN. STR.,% RET. (1)	600psi/40%	4.5.2.4	1595/47	1306/54	3639/81	1115/34 F
ELONGATION, % (1)	100% (MIN)	4.5.2.4	211	215	287	260
COVER, TEN. STR.,% RET. (1)	600psi/40%	4.5.2.4	273/16 F	358/19 F	370/20 F	465/25 F
ELONGATION, % (1)	100% (MIN)	4.5.2.4	166	225	220	163
ORIGINAL ADHESION						
BETWEEN COVER AND PLY	10 ppiw	4.5.2.5	31	(3)	60	35
BETWEEN PLIES (1)	10 ppiw		40	(3)	(3)	45
BETWEEN PLY AND TUBE (1)	10 ppiw		(3)	44	(3)	43
ADHESION AFTER IMMERSION IN JP-8, 70 hrs. @ RT						
BETWEEN COVER AND PLY (1)	6 ppiw	4.5.2.6	(3)	(3)	(3)	(3)
BETWEEN PLIES (1)	6 ppiw		41	43	(3)	7.3
BETWEEN PLY AND TUBE (1)	6 ppiw		42	37	(3)	3.2 F
BRITTLENESS, -60 F, AFTER FUEL EXTRACTION						
TUBE	NONE	4.5.2.7.1	PASS	PASS	PASS	PASS
COVER	NONE		PASS	PASS	PASS	PASS
MODULUS OF ELASTICITY, -60 F AFTER FUEL EXTRACTION						
TUBE	<100,000 psi	4.5.2.7.2	8740	—	—	19650
COVER	<5,000 psi		383	—	—	4646
HEPTANE WASHED GUM	6 mg/100 ml MAX	4.5.2.8	5	5	4	2.5
WEIGHT, Lbs/Ft.	1.3/2.0/5.75	—	1.0	1.7	1.3	—
CRUSH RESISTANCE, @ spec. load, %	85% Orig. O.D.	4.5.2.9	85	87	84 F	91
CRUSH RECOVERY, no load, %	95% Orig. O.D.	4.5.2.9	98	98	98	99
OZONE RESISTANCE	NO CRACKS AT 7X	4.5.2.10	PASS	PASS	PASS	PASS

F - Failure
M - Marginal
(1) - Goodyear Results Based on Fuel B
(2) - Goodyear Results - Average for 3 Sizes
(3) - Specimens Tore, No Result.

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